

REMARKS

Claims 1-28 are presently pending for the Examiner's review and consideration, including new claims 24-28. Claim 1 is presently amended under 35 U.S.C. § 112, second paragraph, to more particularly define the invention, clarifying that the low-frequency roughness that is minimized by the implantation is that of the useful layer surface. Additionally, occurrences of "useful layer surface" are now presented in a consistent manner in claim 1.

In the Office Action, claims 1-6 and 12-23 were rejected under 35 U.S.C. § 103(a) as obvious over Tiwari in view of Barge. Although not specifically stated as being included in this rejection, claims 7-11 are also understood to be rejected over these references because they are independently mentioned in the rejection.

Claim 1 is directed to a method for producing a high quality useful layer of semiconductor material by implanting two different atomic species into a donor substrate, bonding a support substrate thereto, detaching a useful layer from the donor substrate, and thermally treating the detached structure. As recited in claim 1, the implantation of the two different atomic species is conducted to minimize the low-frequency roughness of the useful layer surface that results after the detachment, and the thermal treatment is conducted in a manner to minimize high-frequency roughness of the useful layer surface. The resulting useful layer surface from this process has a sufficient smoothness so that chemical mechanical polishing thereof is not required.

The rejection includes the argument that Tiwari teaches a co-implantation of two different atomic species, and that this would be obvious to combine with the thermal treatment disclosed in Barge, and allegedly that one of ordinary skill in the art would make this combination, finding that Barge discloses that the high-frequency roughness is minimized sufficiently so that chemical mechanical polishing is not required.

As the Examiner indicates, Barge does teach a polishing step 200. It is well known that each reference in a rejection must be taken as a whole, and since both Tiwari and Barge teach that polishing is required to provide an acceptable surface, there is in fact no suggestion to one of ordinary skill in the art that the methods of these two references could be combined to eliminate this polishing step, which is present in both references. One cannot simply pick and choose steps that are taught as necessary in the references to combine to produce the claimed invention. In the present case, picking to eliminate the polishing step

and combine the other steps as argued in the Office Action is merely done with the benefit of hindsight in view of the present application.

The advantage of combining a suitable co-implantation of two different atomic species with a suitable thermal treatment that provides a surface after detachment that is sufficiently smooth to not require any polishing is surprising in view of Tiwari and Barge, since both references require polishing. There is nothing in the references to suggest that a polishing step may not be needed. Since polishing is required in Tiwari, there is no motivation to combine its teaching with Barge to eliminate the polishing step because Barge also requires a polishing step. Similarly, there is no motivation to combine Barge with Tiwari to eliminate the polishing step, since Tiwari also relies on polishing.

Consequently, claim 1 is neither taught nor suggested by any combination of the references taken appropriately as a whole.

New claim 24 defines that the implantation of the different atomic species is conducted so that after the detachment of the useful layer at the weakened zone, the useful layer has a low-frequency roughness of less than about 5 Å, and claim 25 further specifies that this is measured over a sweep area of about $40 \times 40 \mu\text{m}^2$, without chemical mechanical polishing. These are low-frequency roughness levels that are not achievable if an improper dosage and implantation of the different atomic species is used, as shown in Fig. 2 of the present application and the related description. Also, as seen in Fig. 2, it is easier to obtain lower roughness measured over a $10 \times 10 \mu\text{m}^2$ sweep area than over a $40 \times 40 \mu\text{m}^2$ sweep area. These claims are supported, for example, in Fig. 2, and the related description of the originally filed application. There is no suggestion in the cited art that this lower level of roughness can be obtained along with the lower levels of high-frequency roughness without chemical mechanical polishing after the useful layer is detached.


New claim 26 defines that the helium species is implanted in a dose of about $0.9 \times 10^{16} \text{ cm}^{-2}$ or less, and claim 27 further defines that the hydrogen species is implanted at a dose of up to about $0.9 \times 10^{16} \text{ cm}^{-2}$. These values are below what is disclosed in Tiwari and correspond to preferred embodiments described, for example, in the bottom paragraph of page 9 of the present application. As described with respect to Fig. 2, it is seen that the S4 structure does obtain the same low level of roughness as the other structures with the lower dosages of implantation that are recited in claims 26 and 27. Consequently, these dosages provide a surprising result compared to the references, and these claims are also patentably distinct therefrom on their own merits.

Claim 28 defines the preferred rapid thermal annealing process that, as described in the application, results in the surprising and desirable low roughness. As explained above, there is no suggestion or motivation to combine Tiwari and Barge in a manner that allows eliminate of a chemical mechanical polishing step, by providing a low surface roughness after the beneficial rapid thermal annealing process. Claim 28 is thus also patentably distinct from the references.

It is believed that the entire application is presently in condition for allowance. Should any issues remain, a personal or telephonic interview is respectfully requested to discuss the same in order to expedite the allowance of the application.

Respectfully submitted,

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